CLAIMS

We claim:

1. A hand controller or wrist device comprising a base and a moveable portion moveable relative to said base, said moveable portion having a main longitudinal axis and an end point,

a pair of pantographs each formed by a plurality of pivotably interconnected links arranged for pivotal movement in a plane, said planes being mutually perpendicular, means for pivotably mounting each said pantograph adjacent to one of its ends for rotational movement on its pivotal axis relative to said base in a direction substantially perpendicular to its plane and coupling means connecting each of said pantographs adjacent to its end remote from its one end to move said end point in a hemispherical path about a center point when said pantographs are pivoted on their said means for pivotably mounting, said pantographs defining a first and a second degree of freedom of said end point;

said center point being defined by the intersection of said pivotal axes and said main longitudinal axis,

an inner universal joint,

said inner universal interconnecting a first inside element and a second inside element forming a pair of inside elements that define a third degree of freedom of said end point, said first of said inside elements including a pair of portions and means for translating axial movement substantially parallel to said main axis of one of said pair portions of said first inner element to rotational movement of a second portion of said pair of portions of said first inner element and vice versa while permitting relative rotational movement between said one and said second portions, said end point being connected to said one portion of said one of said second pair of elements and,

means for mounting said second inside element for rotation about it axis relative to said base;

said coupling means connecting said pantographs to said one portion while permitting movement of said one portion relative to said pantographs.

2. A hand controller or wrist as defined in claim 1 further comprising an outside universal joint concentric with said inside universal joint combines with said inside universal joint to provide a pair of concentric universal joints, said outside universal joint interconnecting a first outside element and second outside element that form a pair of outside elements; and means coupling said first outside element to said one portion of said first inside element to prohibit relative rotational movement while permitting relative axial movement between said one portion and said first outside element.

3. A hand controller or wrist as defined in claim 2 wherein said pair of outside elements defines a fourth degree of freedom of said end point.

4. A hand controller or wrist as defined in claim 2 wherein said device s a controller and said center point and said inner universal joint pivot point are in the same location.

5. A hand controller or wrist as defined in claim 4 further comprising a separate actuator for each of said degrees of freedom and each said actuator is supported on said base.

6. A hand controller or wrist as defined in claim 5 wherein said device is a controller and said actuators provide force feedback to said end point in each of said degrees of freedom and said center point is defined by the intersection of said pivotal axes and said main longitudinal axis and said end point is moved about said center point by operation said degrees of freedom.

7. A hand controller or wrist as defined in claim 6 wherein said actuator for said third degree of freedom is coupled to said second inside element and through said inner universal joint to said second portion of said first inside element.

8. A hand controller or wrist as defined in claim 7 wherein said means for translating axial movement to rotational movement and vice versa include a belt type drive which includes a pulley formed by a pulley that rotates with said second portion and a belt having a path of travel parallel to said axial movement and connected to said one portion so that movement of said belt moves said one portion substantially axially.

9. A hand controller or wrist as defined in claim 6 wherein said actuator for said fourth degree of freedom includes a belt type drive coupling with said second outside

element of said pair of outside elements and through said outside universal joint with said first outside element of said pair of outside elements.

10. A hand controller or wrist as defined in claim 7 wherein said actuator for said fourth degree of freedom includes a belt type drive coupling with said second outside element of said pair of outside elements and through said outside universal joint with said first outside element of said pair of outside elements.

11. A hand controller or wrist as defined in claim 8 wherein said actuator for said fourth degree of freedom includes a belt type drive coupling with said second outside element of said pair of outside elements and through said outside universal joint with said first outside element of said pair of outside elements.

12. A hand controller or wrist as defined in claim 1 further comprising separate actuators for each of said degrees of freedom.

13. A hand controller or wrist as defined in claim 10 wherein said device is a wrist and said actuators drive said end point in each of said degrees of freedom.

14. A hand controller or wrist as defined in claim 13 wherein said means for mounting said second inside element for rotation about it axis includes a second inside universal joint, said second inside universal joint coupled on one side to said second inside element and its other side is rotatably mounted on said base on said base.

15. A hand controller or wrist as defined in claim 14 further comprising an outside universal joint concentric with said inside universal joint combines with said inside universal joint to provide a pair of concentric universal joints, said outside universal joint interconnecting a first outside element and second outside element that form a pair of outside elements; and means coupling said first outside element to said one portion of said first inside element to prohibit relative rotational movement while permitting relative axial movement between said one portion and said first outside element and wherein a second outside universal joint concentric with said second inside universal joint combines with said second inside universal joint to provide a second pair of concentric universal joints, said second outside universal joint coupled on one side to said second outside element and its other side is rotatably mounted on said base.

16. A hand controller or wrist as defined in claim 15 wherein said actuator for each of said first and second degrees of freedom includes a belt type drive drivingly interconnecting its respective said means for pivotably mounting with its actuator.

17. A hand controller or wrist as defined in claim 16 wherein said actuator for said third degree of freedom is coupled to one side of said second inside universal joint and another side of said second inner universal joint is connected to said second inside element and through said inner universal joint to said second portion of said first inside element.

18. A hand controller or wrist as defined in claim 16 wherein said actuator for said fourth degree of freedom includes a belt type drive coupling with one side of said first outside universal joint.

19. A hand controller or wrist as defined in claim 16 wherein said means for translating axial movement to rotational movement and vice versa includes a worm type gear.

20 A hand controller or wrist as defined in claim 16 wherein said one portion is a module.